Percent Increase and Percent Decrease The percent increase is the amount of increase divided by the original value, expressed as a percent. The percent decrease is the amount of decrease divided by the original value, expressed as a percent.	See **Examples 12 and 13** on pages 531 and 532, and then try Exercises 17, 26, and 27 on pages 551 and 552.
9.4 Second-Degree Equations	
Steps in Solving a Second-Degree Equation by Factoring **1.** Write the equation in standard form. **2.** Factor the polynomial $ax^2 + bx + c$. **3.** Use the principle of zero products to set each factor of the polynomial equal to zero. **4.** Solve each of the resulting equations for the variable.	See **Example 3** on page 539, and then try Exercise 6 on page 550.
The Quadratic Formula The solutions of the equation $ax^2 + bx + c = 0$, $a \neq 0$, are $$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}.$$	See **Examples 4 and 5** on page 541, and then try Exercises 7 and 8 on page 550.
Applications of Solving Second-Degree Equations The solution to an application problem may require solving a second-degree equation.	See **Examples 6 and 7** on pages 542 and 543, and then try Exercises 31 and 32 on page 552.

CHAPTER 9 REVIEW EXERCISES

(p550)

■ In Exercises 1 to 8, solve the equation.

1. $5x + 3 = 10x - 17$

Subtract $5x$. Add 17. Divide 5.

$3 = 5x - 17$

$20 = 5x$

$4 = x$

2. $3x + \frac{1}{8} = \frac{1}{2}$

Distribute skewed easy: Leave exact answers (don't turn fractions into decimals), & simplify.

Cross multiply. Divide 12. Reduce.

$12n = 40$

$n = 40/12$

$n = \boxed{10/3}$

3. $6x + 3(2x - 1) = -27$

Distribute. Combine. Add 3. Divide 12.

$6x + 6x - 3 = -27$

$12x - 3 = -27$

$12x = -24$

$x = \boxed{-2}$

4. $\frac{5}{12} = \frac{n}{8}$

6. $x^2 - x = 30$

7. $x^2 = 4x - 1$

8. $x + 3 = x^2$

9. $4x + 3y = 12; y$ "Literal equation" Distribute; solve for y.

Subtract $4x$. Divide 3.

$3y = 12 - 4x$

$y = \boxed{4 - \frac{4}{3}x}$

(Also acceptable: $y = \frac{12-4x}{3}$)

10. $f = v + at; t$ Solve for: t

Subtract v. Divide a.

$f - v = at$

$\frac{f-v}{a} = t$

(Also a good answer: $\frac{f}{a} - \frac{v}{a}$)

11. Meteorology In June, the temperature at various elevations of the Grand Canyon can be approximated by the equation $T = -0.005x + 113.25$, where T is the temperature in degrees Fahrenheit and x is the elevation (distance above sea level) in feet. Use this equation to find the elevation at Inner Gorge, the bottom of the canyon, where the temperature is 101°F.

Given. $T = -0.005x + 113.25$

Plug in. $101 = -0.005x + 113.25$

Solve for x...

Subtract 113.25. $-12.25 = -0.005x$

Divide -0.005. $\boxed{2450} = x$

feet

The Grand Canyon

12. Falling Objects Find the time that it takes for the velocity of a falling object to increase from 4 ft/s to 100 ft/s. Use the equation $v = v_0 + 32t$, where v is the final velocity of the falling object, v_0 is the initial velocity, and t is the time it takes for the object to fall.

13. Chemistry A chemist mixes 100 g of water at 80°C with 50 g of water at 20°C. Use the formula $m_1(T_1 - T) = m_2(T - T_2)$ to find the final temperature of the water after mixing. In this equation, m_1 is the quantity of water at the hotter temperature, T_1 is the temperature of the hotter water, m_2 is the quantity of water at the cooler temperature, T_2 is the temperature of the cooler water, and T is the final temperature of water after mixing.

"Rate question"

15. Fuel Consumption An automobile was driven 326.6 mi on 11.5 gal of gasoline. Find the number of miles driven per gallon of gas.

"mpg"

Method 1: $326.6 \text{ mi} / 11.5 \text{ gal} = \boxed{28.4 \text{ mi/gal}}$

Method 2: $\frac{326.6 \text{ mi}}{11.5 \text{ gal}} = \frac{x \text{ mi}}{1 \text{ gal}}$

Cross multiply. Divide 11.5.

$326.6 = 11.5x$

$\boxed{28.4} = x$

mi/gal

16. Real Estate A house with an original value of $280,000 increased in value to $350,000 in 5 years. Write, as a fraction in simplest form, the ratio of the increase in value to the original value of the house.

answer will be a fraction (don't convert to percent)

Find increase in value: $350000 - 280000 = 70000$

Write ratio of increase to original: $70000 / 280000$

Reduce (Divide top, bottom by 10000, again by 7)

$\boxed{7/28}$

$\boxed{1/4}$

18. **City Populations** The table below shows the population and area of the five most populous cities in the United States.

a. The cities are listed in the table according to population, from largest to smallest. Rank the cities according to population density, from largest to smallest.

b. How many more people per square mile are there in New York than in Houston? Round to the nearest whole number.

City	Population	Area (in square miles)
New York	8,400,000	321.8
Los Angeles	3,900,000	467.4
Chicago	2,900,000	228.469
Houston	2,300,000	594.03
Phoenix	1,600,000	136

19. **Student–Faculty Ratios** The table below shows the number of full-time men and women undergraduates, as well as the number of full-time faculty, at five colleges in Arizona. In parts a, b, and c, round ratios to the nearest whole number. (*Source:* National Center for Education Statistics, nces.ed.gov)

University	Men	Women	Faculty
Arizona State University	20,309	15,955	2018
Embry-Riddle Aeronautical University	1441	428	93
Northern Arizona University	8215	10,958	1055
Prescott College	156	215	56
University of Arizona	14,054	15,475	2343

a. Calculate the student–faculty ratio at Prescott College. Write the ratio using a colon and using the word *to*. What does this ratio mean?

b. Which school listed has the lowest student–faculty ratio? The highest?

c. Which schools listed have the same student–faculty ratio?

20. **Advertising** The Randolph Company spent $350,000 for advertising last year. Department A and Department B share the cost of advertising in the ratio 3 : 7. Find the amount allocated to each department.

21. **Gardening** Three tablespoons of a liquid plant fertilizer are to be added to every 4 gal of water. How many tablespoons of fertilizer are required for 10 gal of water?

a. Is more or less than one-fifth of federal spending spent on health care?

b. Find the ratio of the fixed expenditures to the discretionary spending.

c. Find the amount of the budget to be spent on fixed expenditures.

d. Find the amount of the budget to be spent on Social Security.

How Your Federal Tax Dollar Is Spent

23. **Demographics** According to the U.S. Bureau of the Census, the population of males and females in the United States in 2025 and 2050 is projected to be as shown in the table below.

Year	Males	Females
2025	164,119,000	170,931,000
2050	193,234,000	200,696,000

a. What percent of the projected population in 2025 is female? Round to the nearest tenth of a percent.

b. Does the percent of the projected population that is female in 2050 differ by more or less than 1% from the percent that is female in 2025?

24. **Diet** Americans consume 7 billion hot dogs from Memorial Day through Labor Day. This is 35% of the hot dogs consumed annually in the United States. (*Source:* National Hot Dog & Sausage Council: American Meat Institute) How many hot dogs do Americans consume annually?

25. **Boston Marathon** In the 2015 Boston Marathon, 27,167 runners started the race and 26,598 finished. What percent of the runners who started the course finished the race? Round to the nearest tenth of a percent.

26. **Nutrition** The table below shows the fat, saturated fat, cholesterol, and calorie content of a 90-gram ground-beef burger and a 90-gram soy burger.

a. Compared to the beef burger, by what percent is the fat content decreased in the soy burger?

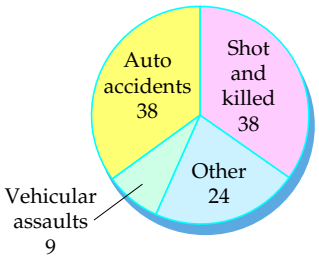
b. What is the percent decrease in cholesterol in the soy burger compared to the beef burger?

c. Calculate the percent decrease in calories in the soy burger compared to the beef burger.

	Beef burger	Soy burger
Fat	24 g	4 g
Saturated fat	10 g	1.5 g
Cholesterol	75 mg	0 mg
Calories	280	140

27. **The Military** On Veterans Day in 2000, there were 26.6 million U.S. veterans. By Veterans Day in 2010, the number of U.S. veterans had dropped to 23.1 million. (*Source:* Department of Veterans Affairs) Find the percent decrease in the number of veterans from 2000 to 2010. Round to the nearest tenth of a percent.

28. **Police Officers** The graph below shows the causes of death for all police officers killed in the line of duty during a recent year. What percent of the deaths were due to auto accidents? Round to the nearest percent.



Causes of Death for Police Officers Killed in the Line of Duty
SOURCE: www.policespecial.com

29. **Retirement Programs** Massachusetts teachers enrolled in the Retirement-Plus savings program contribute 11% of their salaries to the program. What amount is contributed during 1 year by a member of this program who earns an annual salary of $64,000?

30. **Vacation Days** In Italy, workers take an average of 42 vacation days per year. This number is 3 more than three times the average number of vacation days that workers take each year in the United States. (*Source:* World Tourism Organization) On average, how many vacation days do U.S. workers take per year?

31. **Model Rockets** A small rocket is shot from the edge of a cliff. The height h, in meters, of the rocket above the cliff is given by $h = 30t - 5t^2$, where t is the time in seconds after the rocket is shot. Find the times at which the rocket is 25 m above the cliff.

32. **Sports** The height h, in feet, of a ball t seconds after being thrown from a height of 6 ft is given by the equation $h = -16t^2 + 32t + 6$. After how many seconds is the ball 18 ft above the ground? Round to the nearest tenth.

CHAPTER 9 TEST

■ In Exercises 1 to 5, solve the equation.

1. $\frac{x}{4} - 3 = \frac{1}{2}$

2. $x + 5(3x - 20) = 10(x - 4)$

3. $\frac{7}{16} = \frac{x}{12}$

4. $x^2 = 12x - 27$

5. $3x^2 - 4x = 1$

■ In Exercises 6 and 7, solve the formula for the given variable.

6. $x - 2y = 15;\ y$

7. $C = \frac{5}{9}(F - 32);\ F$